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ABSTRACT

This report provides data from a survey of a nationally representative sample of more than 2,000 public- and private-school teachers of 4th through 12th grade regarding Internet use by teachers and students. Information is provided about: (1) teachers' access to the Internet; (2) frequency of different Internet uses, including teachers' uses and teacher-directed student use; (3) the Internet's perceived value for teachers; (4) correlates of Internet use and perceived value, including measures of use employed, association between Internet access and use, teaching responsibilities and Internet use, experience and expertise, school support for teaching using technology, and pedagogical beliefs and practices; and (5) multivariate analysis of all predictors considered together (i.e., Internet access, teaching responsibilities, technology expertise, professional experience, school support for teaching, and pedagogical beliefs and practices) and of the factors that most differentiate users and non-users; and (6) conclusions. Data are presented in 28 tables and figures throughout the report. A summary of the study methodology is appended. (AEF)

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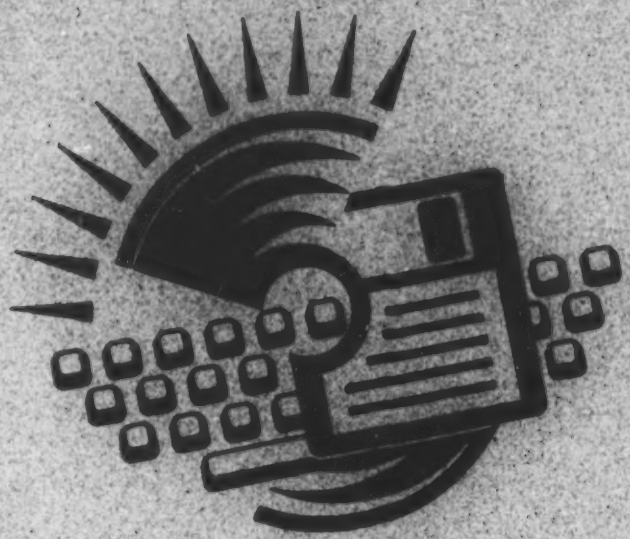
Internet Use by Teachers:

Conditions of Professional Use and Teacher-Directed Student Use

Henry Jay Becker



Teaching, Learning, and Computing: 1998 National Survey

Report #1

Center for Research on Information Technology and Organizations
The University of California, Irvine
and
The University of Minnesota

February, 1999

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Source: http://www.crito.uci.edu/TLC/findings/Internet-Use/startpage.htm

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INTRODUCTION

Although the potential impact of computer technologies on teaching and learning goes far beyond the Internet, the Internet's rapid growth in the last two to three years suggested that we devote our first presentation of findings from the TLC survey to Internet use by teachers and their students. An earlier analysis of the same data was presented at Tel-Ed 1998, San Antonio, TX, October 30th, 1998. This paper provides a revised and more extended analysis, and includes information about...

- How frequently teachers and students use the Internet and in what ways
- To what extent teachers value having the Internet in their own classroom
- How much access teachers have to the Internet
- Variations in Internet use and perceived value by the teacher's level of Internet access
- Variations in Internet use and value by teaching responsibility
- Internet use and value by professional experience and technology expertise
- Internet use and value by whether teachers participated in staff development
- Internet use and value by the school professional climate
- Internet use and value by the teacher's pedagogical approach
- Combined effects on Internet use of all predicting factors

A further-revised and extended version of this paper will include information about access to the Internet at the school-level, information on how Internet use is affected by school support for technology, and additional multivariate analyses of teacher use not included here.

STUDY SAMPLE

The information presented here derives from the national probability sample of teachers of 4th through 12th grade classes in U.S. public and private schools conducted in the Spring of 1998. Approximately 2,250 teachers in the probability sample responded to the survey (69.4% of the teachers identified and sampled) and are included in the charts below. Statistics presented are weighted to constitute a nationally representative sample of teachers.[1]

PART I. TEACHERS' ACCESS TO THE INTERNET

Over the past five years, schools have been rapidly acquiring access to Internet telecommunications. This has been shown through information provided by the National Center for Education Statistics, as well as our own 1998 data on school-level Internet connectivity (to be included in Report #2A). Over 90% of schools now have some sort of access to the Internet, someplace in their building.[2] **[TABLE 1]**

TABLE 1: PERCENT OF PUBLIC SCHOOLS WITH ANY INTERNET ACCESS, BY YEAR

	1994	1995	1996	1997	1998
Percent of Public Schools	35%	50%	65%	78%	90%

Sources: Data for 1994-1997 from NCES Issue Brief 98-031. Data for 1998 from Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

[1] See appendix at the end of this document for further information about the sample and data collection methodology.
[2] For each table in the text, there is an accompanying figure located in a separate pdf document called "Figures." In most cases, the figure contains the same data (or subset of the data) as in the table.

Until very recently, though, the *type* of Internet access that schools had was limited to individual telephone modems connected to single computers, sometimes in a teacher's classroom, but more often in an office or computer lab. It is quite remarkable, then, that more than one-third of U.S. teachers (39%, among 4^{th} – 12^{th} grade teachers) now have some kind of Internet access in their own classroom. **[TABLE 2]**

TABLE 2: INTERNET CONNECTIONS IN CLASSROOM, BY TEACHER'S SCHOOL LEVEL

	Type of Internet Connection in Teacher's Classroom		
	None	Modem	Direct Thru LAN
Elementary Teachers	64%	21%	15%
Middle School Teachers	60%	23%	16%
High School Teachers	61%	19%	20%
All teachers	61%	21%	18%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Moreover, nearly as many teachers have high-speed direct Internet connection routed through a local area network to their classroom as have the older, and slower, "dial-up" modem connection.[3, 4]

In addition to the 39% of teachers who have Internet access in their classrooms, another 25-30% teach at schools where at least some instructional rooms in their building have LAN-based internet connectivity. Moreover, a majority of teachers (59%) have Internet access at home and only one-quarter (27%) have no access either at home or in their classroom. **[TABLE 3]**

TABLE 3: TEACHER INTERNET ACCESS AT HOME AND IN THEIR CLASSROOM

	Percent
Both home and classroom	24%
Classroom only	15%
Home only	35%
Neither	27%
All teachers	100%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

These statistics suggest that, as with other knowledge-oriented professionals, the Internet has begun to be established as an information and communications resource in the working and home environments of most teachers. The next question is whether and to what extent teachers have begun using this resource in their professional lives.

[3] The percentage of teachers with direct (non-modem) Internet connections (and the particular teachers so ascribed) had to be imputed from survey data, since the question about direct access itself proved to be ambiguous. The question had been phrased in terms of "high speed access," which was contrasted to "modem access," but apparently many teachers regarded their modem access as "high-speed."

[4] Note that this result, though tentative because of the problem just cited, occurred well in advance of schools receiving funds through federal e-rate programs.

PART II. FREQUENCY OF DIFFERENT INTERNET USES

A. TEACHERS' USES

1. USE IN LESSON PREPARATION

Most teachers report making some use of the Internet in their professional activities. Our survey asked about three professional uses in particular: finding information and other resources on the Internet; e-mailing with teachers at other schools; and posting information, suggestions, opinions, or student work on the World Wide Web.

A majority of teachers (68%) use the Internet in their effort to find information resources for use in their lessons, and more than one-quarter of all teachers report doing this on a weekly basis or more often (28%). **[TABLE 4]**

TABLE 4: HOW OFTEN TEACHERS USE INFORMATION FROM INTERNET IN LESSONS, BY HOME AND CLASSROOM INTERNET CONNECTIVITY

Location of Internet Access	Do Not Use	Occasionally	Weekly or more often
Both home and classroom	10%	45%	46%
Home only	26%	45%	30%
Classroom only	24%	47%	29%
Neither	66%	26%	8%
All teachers	32%	40%	28%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Teachers who use the Internet in this way typically have either home or classroom access. Both home and classroom access are about equally related to use, and teachers who have the combination of both home and classroom access report the most frequent use, with 46% of such teachers reporting weekly or more frequent use. Of course, it is also likely that teachers who want to use the Internet may go to some effort to acquire either home or classroom access, but it also may be that the presence of the technology increases utilization. Despite these findings, it is also true that even among teachers with both home and classroom Internet access, more teachers report only "occasional" use of the Internet for lesson preparation than report use on at least a weekly basis.

2. TEACHER PROFESSIONAL COMMUNICATIONS

The survey asked about two additional areas of professional use of the Internet by teachers—e-mail with teachers from other schools and publishing on the World Wide Web. Far fewer teachers engage in these types of communications than use Internet as an information-gathering tool to obtain resources for lesson preparation. Only 16% of teachers communicated by e-mail with teachers from other schools as often as five times during the school year. **[TABLE 5]**

TABLE 5: TEACHERS' USE OF ELECTRONIC MAIL TO COMMUNICATE WITH TEACHERS IN OTHER SCHOOLS, BY HOME AND CLASSROOM INTERNET CONNECTIVITY

Location of Internet Access	Have not done (since Sept.)	Occasionally	More than 5 times (since Sept.)
Both home and classroom	32%	34%	33%
Classroom only	47%	33%	20%
Home only	70%	21%	9%
Neither	85%	10%	5%
All teachers	61%	23%	16%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

However, classroom access to the Internet may make a difference in whether they use e-mail for professional purposes: Teachers with Internet access both at home and in their classroom were more than three times as likely to e-mail teachers at other schools than teachers who had only home Internet access (33% vs. 9%).

Also, relatively few teachers have begun posting information, suggestions, opinions, or student work on the World Wide Web. Only 18% of teachers did this at all last year. **[TABLE 6]**

TABLE 6: PERCENT OF TEACHERS POSTING INFORMATION, OPINIONS, OR STUDENT WORK TO WORLD WIDE WEB (AT ANY TIME DURING THE YEAR) BY HOME AND CLASSROOM CONNECTIVITY

Internet Access	
Both home and classroom	30%
Classroom only	20%
Home only	17%
Neither	9%
All teachers	18%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

While this is a relatively small percentage of teachers, publishing information on the Web is a substantially new activity, not within the experience of teachers as much as electronic mail or web browsing might be. To have even that many teachers involved in some way suggests that more growth in this area should be expected, as teachers' experience with using the Internet develops their interest and confidence in being information producers as well as consumers.

B. TEACHER-DIRECTED STUDENT USE

1. STUDENT INFORMATION-GATHERING (STUDENT RESEARCH)

Just as information-gathering for lesson preparation is the most common use of the Internet by teachers, teachers have students use the Internet for "research," or information-gathering, more than for any other purpose. In fact, in the past two years, Web searching has become the third most common use of computers by students at school, after word processing and use of CD-ROMs. Web searching even slightly surpasses skills practice by computer drills and learning games in terms of how frequently teachers have students use computers in that way. **[TABLE 7]**

TABLE 7: PERCENT OF TEACHERS HAVING THEIR STUDENTS USE DIFFERENT TYPES OF SOFTWARE BY GRADE LEVEL

	Word Processing	CD-ROM Reference	World Wide Web	Games/ Drills	Simulations	Graphics	Spreadsheet/ Database	Multimedia Authoring	Email
Elementary	65%	54%	26%	63%	33%	26%	10%	14%	7%
Middle	44%	32%	26%	21%	18%	19%	16%	8%	6%
High	45%	29%	34%	11%	21%	20%	20%	8%	8%
All teachers	50%	36%	29%	28%	23%	21%	16%	9%	7%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Although only a minority of teachers had students use Web browsers during the last school year, the effects of having classroom-located Internet connectivity seems to have been large, at least in terms of baseline levels of use. Among teachers with modems in their classroom, nearly half had students use Web browsers on at least 3 occasions. What might be called "regular" use—using the World Wide Web to do research on at least 10 occasions—was a practice of nearly one-quarter of all teachers with a modem in their classroom and 30% of those with direct high-speed connections. **[TABLE 8]**

TABLE 8: STUDENT USE OF WEB BROWSER SOFTWARE IN LESSONS, BY TYPE OF CLASSROOM INTERNET CONNECTIVITY

	No Use	1-2 Lessons	3-9 Lessons	10+ Lessons
None	78%	8%	9%	5%
Modem	37%	18%	22%	24%
Direct-LAN	28%	11%	31%	30%
All	60%	11%	16%	13%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Of course, with a limited number of computer stations in the classroom, the amount of experience that any one student may have had with Web-based research could be quite limited.

2. STUDENT PROJECTS AND PUBLISHING

Beyond the traditional activity of using information sources to write reports, some teachers have had students use the Internet to contact other individuals, to collaborate with classes in other schools in joint projects, and to become experts on a topic and publish their findings on the World Wide Web. As of 1997-98, however, very few teachers have had their students involved in those Internet-based activities. Overall, 7% of teachers had students e-mail at least 3 times during the school year, and even fewer involved students in cross-classroom collaborative projects or in Web publishing. **[TABLE 9]**

TABLE 9: INTERNET USE FOR BEYOND-CLASSROOM STUDENT PROJECTS AND PUBLISHING, BY TEACHER'S SUBJECT AND SCHOOL LEVEL

	Students e-mailed in 3+ lessons	Participation in x-school projects	Kids published on web
Computers, HS and MS	17%	12%	12%
Vocational & Fine Arts, HS and MS	11%	3%	3%
High School "Academic"	9%	6%	4%
Middle School "Academic"	5%	6%	4%
Elementary - Mixed Subjects	8%	6%	2%
Math, HS and MS	1%	4%	2%
"Other" subject/level comb.	6%	7%	5%
Total	7%	6%	4%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Among teachers whose primary teaching responsibility concerned the subject of computers (as opposed to other subject-matter areas), use of the Internet for these purposes was somewhat more common. Between 12 and 17% of computer-subject teachers had students use the Internet for each of those three purposes—e-mail, cross-classroom collaborations, and Web publishing. In some cases, it may be that student project work in a computer class is linked to instruction occurring in their subject-matter classes. But this is probably not true most of the time.

PART III. THE INTERNET'S PERCEIVED VALUE FOR TEACHERS

Even though a majority of teachers have still not used the Internet in their teaching, and even fewer have used it in a major way, there may be many reasons for this – the recent development of Internet tools and resources, the rapidity with which technologies are changing, the limited opportunity that teachers have had to see how the Internet can be used in their practice, and the rarity of fast and convenient Internet access. Some teachers who have not used the Internet may be looking forward to a day when they might. How do teachers see the Internet's potential value for them in the near future? Do most teachers see the Internet as a valuable or an essential resource in their teaching, as something of limited value, or perhaps something that is not even needed?

We asked teachers about the value of the Internet in two respects: the value of a teacher's computer station with electronic mail access; and the value of having World Wide Web access in their classroom. In each case, almost one-half of all teachers saw these resources as "essential" for their teaching (49% and 47% respectively) and nearly 90% reported that they would consider these resources either valuable or essential. Even among teachers who did not have access to the Internet either at home or in their own classroom, one-third regarded the Internet as an essential teaching resource. **[TABLE 10 & 11]**

TABLE 10: TEACHERS' PERCEIVED VALUE OF HAVING A COMPUTER WITH ELECTRONIC MAIL ON THEIR OWN DESK, BY CURRENT HOME AND CLASSROOM INTERNET ACCESS

	Not needed	Some Value	Valuable	Essential
Both home and classroom	0%	3%	27%	70%
Classroom only	4%	7%	34%	55%
Home only	2%	9%	45%	44%
Neither	8%	15%	43%	34%
Total	4%	9%	38%	49%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

TABLE 11: TEACHERS' PERCEIVED VALUE OF CLASSROOM WORLD WIDE WEB ACCESS BY CURRENT HOME AND CLASSROOM ACCESS

	Not needed	Some Value	Valuable	Essential
Both home and classroom	0%	3%	32%	65%
Classroom only	1%	8%	41%	50%
Home only	1%	9%	45%	45%
Neither	9%	17%	43%	32%
All teachers	3%	9%	41%	47%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

PART IV. CORRELATES OF INTERNET USE AND PERCEIVED VALUE

Clearly, the access that teachers have to the Internet as well as their teaching responsibilities affects the likelihood that they will use the Internet themselves or with their students and, to some extent, whether they have come to value this resource in their teaching. This section reports our analysis of the degree to which different factors are correlated with teachers' Internet use and perceived value.

A. MEASURES OF USE EMPLOYED

Three measures of Internet use are employed, and each measure is based on two or three dichotomous criteria (i.e., meeting or not meeting a given standard). Thus, each teacher received a score of 0, 1, 2, or 3 in each of these categories.

A teacher's TEACHER USE score is the number of the following three criteria met:

- Did they get information from the Internet on a weekly basis?
- Did they send e-mails to teachers at other schools at least 5 times during the year?
- Did they ever post information or student work to the World Wide Web during the year?

A teacher's STUDENT RESEARCH USE score is the number of these three criteria met:

- Did they have students use the World Wide Web in at least 3 lessons during the year?
- Did they have students use the Web at least 10 times?
- Did they choose an Internet browser software as one of the three most valuable pieces of software used in their teaching?

A teacher's STUDENT PROJECTS AND PUBLISHING score comes from three criteria as well:

- Did they have students do e-mail in at least 3 lessons?
- Did they have a class participate in a cross-school collaborative project?
- Did they do a lesson where students became expert in a topic and put their information on the Web?

Finally, a teacher's PERCEIVED VALUE score is the combination of whether they believed desktop e-mail for themselves was essential and whether they believed classroom Web access was essential. Each of these numerical scores can also be converted to a fraction of the maximum possible score, for individual teachers or for groups of teachers. In other words, if, on average, a group of teachers met 1.5 of the 3 criteria for Student Research Use, then that group of teachers would have an average score of 1/2 (1.5 divided by 3) for Student Research Use. Here we convert these fractions to decimals and would report that average score as .50. (These decimals are essentially an average of the percentage of teachers who met a typical criterion in the set.)

Across all teachers, the mean scores for the four measures of Internet use and perceived value are shown below (standard deviations in parenthesis):
.48 (.44)Perceived Value
.21 (.28)Teacher Use
.20 (.34)Student Research
.05 (.15)Student Projects and Publishing

B. ASSOCIATION BETWEEN INTERNET ACCESS AND USE

Certainly teachers have to have access to the Internet in order to use it. But what kind of access makes the biggest difference in use and perceived value—whether the teacher has access at home or somewhere in school; whether the school access is in her own classroom; or whether her classroom access is through a modem or through high-speed/LAN-based direct access? Our data provides some evidence on this issue.

In terms of a teacher's own professional Internet use, having a modem at home may be almost as important for teachers as having one in their classroom. Teachers with a home modem but no access at school at all have nearly the same Teacher Use score as teachers with an Internet connection in their classroom but no modem at home (.23 vs. .20). Moreover, teachers with a home modem but working in a school without Internet connectivity still have an average Internet Use score that is twice what teachers have who have Internet access somewhere in their school but not at home and not in their own classroom. Teachers with home Internet access also have stronger beliefs about the need for Internet in their teaching. **[TABLE 12]**

TABLE 12: INTERNET USE/VALUE SCORES BY LOCATION OF TEACHER'S INTERNET ACCESS

Location of Access	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
None	.37	.06	.01	.01
Elsewhere in School	.30	.09	.10	.02
Home only	.42	.20	.07	.02
Home & elsewhere	.46	.18	.13	.03
Classroom only	.53	.23	.32	.09
Classroom & home	.68	.36	.42	.12

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

For student use, teachers with Internet access in their own classroom are much more likely to assign students to do work on the Internet than where access is limited to locations outside of their own classroom. It does look from these data (Table 12) that home Internet access is an advantage for teachers even for stimulating teacher-directed student use. For example, the average Student Research score for teachers with both home and classroom access is .41 and for those with only classroom access it is .32. However, teachers who have a home modem may be initially different from non-modem owning teachers in terms of other factors that make them more likely to assign students Internet-based work. They may perceive the Internet to be more relevant to their teaching responsibilities (so that is why they have a modem), or they may have greater computer expertise. Multivariate analysis shown later in this paper suggests that such an explanation may be true. Controlling on other factors, having a home modem only affects Teacher Professional Use, not teacher-directed Student Use.

There are also differences in Internet use and perceived value between teachers with LAN-based direct high-speed Internet connections in their classroom compared to teachers with simple dial-up modem access. These differences are probably understated by our data as indicated in the note above. Teacher Use and Student Research percentages are both somewhat higher for classrooms with LAN-based-direct connectivity than in classrooms with modem connections.

It is not, however, just the speed and ease-of-use factors that may be responsible for these differences. Classrooms with LAN-based-direct connections are more likely to have at least several computers with simultaneous Internet connections than classrooms where each connection requires a separate modem. We find the greatest levels of student use, both for Student Research and for Student Projects and Publication, in classrooms with LAN-based Internet connections where at least 4 computers are present as well. (The accompanying figure shows this for teachers with home modem access as well but this is true overall, too.) **[TABLE 13]** & **[FIGURE 13]**

FIGURE 13: INTERNET USE/VALUE AND LEVELS OF CLASSROOM CONNECTIVITY, FOR TEACHERS WITH HOME ACCESS

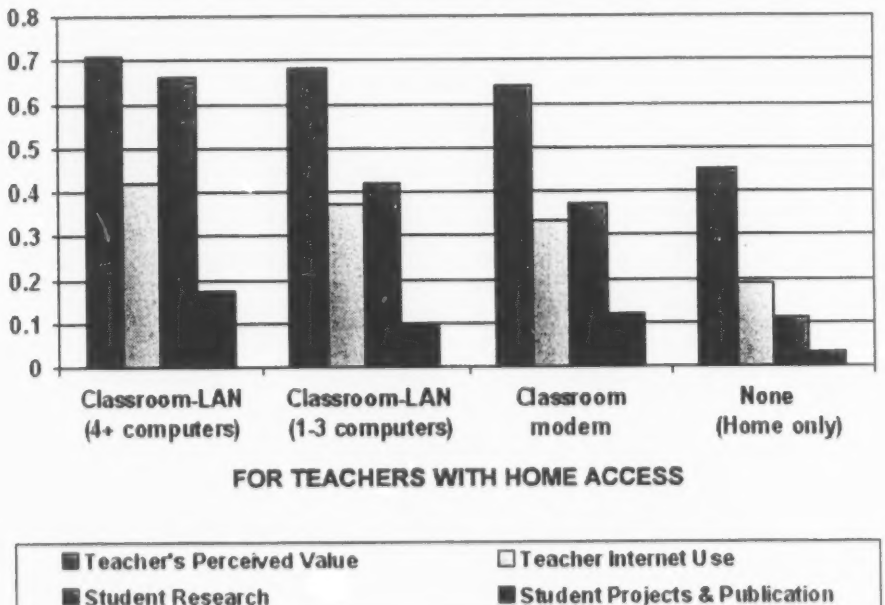


TABLE 13: INTERNET USE/VALUE AND LEVELS OF CLASSROOM CONNECTIVITY, CONTROLLING ON HOME ACCESS

	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Neither	.33	.08	.06	.02
Home only	.44	.19	.11	.03
Classroom modem only	.53	.20	.29	.08
Both home and class modem	.67	.35	.36	.12
Classroom-thru-LAN-direct	.50	.27	.35	.10
Home & classroom-LAN with 1-3 computers	.68	.37	.42	.10
Home & classroom-LAN with 4+ computers	.71	.42	.66	.17

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Among those teachers who have 4 or more computers in classrooms with LAN-based connections (and home modems as well), the average Student Research score is .66, and the average Projects & Publication score is .17, substantially higher than in classrooms with fewer directly-connected computers or where Internet connection is by modem.

C. TEACHING RESPONSIBILITIES AND INTERNET USE

1. SUBJECT-MATTER AND GRADE LEVEL RESPONSIBILITIES

The fact that student Internet use is higher in classrooms with LAN-based direct Internet connections feeding multiple numbers of computers could be partly due to different subjects being taught in classrooms with more Internet connectivity. To a large degree, teaching students to use computer resources such as the Internet remains a specialized province of the "computer teacher" rather than having been integrated into the instructional repertoire of teachers across all subjects. Thus, computer teachers would be expected to have both greater connectivity and to report greater amounts of use.

Our analysis of differences in teachers' Internet use based on their teaching responsibilities employs a typology of six categories (plus "other") that is partly based on subjects taught and partly based on school level (grade levels taught). In this typology, teachers of science, social studies, English, and other humanities subjects are grouped together under the label "academic subjects" because their basic pattern of Internet use was not noticeably different from one another. Math teachers were separated out from these other academic subjects because they showed very different patterns of Internet use.[5]

Subject-matter comparisons reveal some consistent patterns with respect to the three types of Internet use and value that were examined. Computer class teachers in secondary school reported the highest scores on all four measures, particularly on the student use measures. **[TABLE 14]**

[5] Teachers whose responsibilities place them into more than one of the six categories (i.e., math-science teachers) were placed into the residual ("other") category unless more than 50% of their classes reflected a single category.

TABLE 14: INTERNET USE/VALUE AND TEACHING RESPONSIBILITIES: SUBJECT-MATTER AND SCHOOL LEVEL

Subject/Level	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Computer Classes (HS & MS)	.68	.27	.40	.13
High School "Academic"	.59	.23	.28	.06
Vocational & Fine Arts (HS & MS)	.55	.20	.19	.06
Middle School "Academic"	.47	.22	.19	.05
Elementary Self-contained	.48	.21	.17	.06
Mathematics (HS & MS)	.32	.12	.09	.02
Other	.43	.23	.21	.06

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Next to computer teachers, high school teachers of "academic" subjects (mainly science, social studies, and English) had slightly higher use and value scores than other teachers. By far the lowest scores on all four measures including teacher Internet use, student use, and perceived value were those of mathematics teachers. Overall, high school teachers had somewhat higher perceived value scores and higher Student Research Use scores than other levels. **[TABLE 15]**

TABLE 15: INTERNET USE/VALUE BY SCHOOL LEVEL TAUGHT

School Level	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Elementary	.46	.19	.18	.06
Middle School	.47	.21	.18	.05
High School	.51	.21	.24	.05

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Perhaps the most interesting finding in this section is the sharply lower measures of Internet use and perceived value held by math teachers compared to every other group. Only 12% use the Internet themselves (using the mean value for the three Teacher Use criteria) compared to more than 20% for every other teacher category. Only 9% of math teachers have students use the Internet for gathering information, compared to 17% of elementary mixed-subject teachers and 19% or more for every other group of teachers. And use of Internet-based student cross-school project and publication work rarely exists among math teachers, being only one-third as frequent as with other teacher populations. Clearly, math teachers have not figured out how to use the Internet in their curriculum, nor do as many see it as essential as do other teachers.

2. CHARACTERISTICS OF STUDENTS TAUGHT: PRIOR ACHIEVEMENT LEVELS

A rough measure of prior academic performance was provided by teachers about the students in each of the classes which they taught. Teachers were divided into three groups according to the average achievement levels across classes that they reported—low, average, and high. This procedure identified 19% of teachers as generally teaching high-performing students and 14% teaching primarily low-performing students. Teachers assigned to "high-achieving" classes were slightly more likely to use the Internet and to find it essential in their teaching than teachers with "average" classes, and the teachers of "average" classes were slightly more likely than teachers with "low" classes to use it as well. **[TABLE 16]**

TABLE 16: INTERNET USE/VALUE BY PRIOR ACHIEVEMENT LEVELS OF STUDENTS TAUGHT

Students' Prior Achievement	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Low prior achievement	.47	.17	.18	.03
Average prior achievement	.47	.20	.20	.05
High prior achievement	.55	.26	.23	.08
Average, all teachers	.48	.21	.20	.05

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

C. EXPERIENCE AND EXPERTISE

The value of teaching resources depends to some extent on teachers' having pre-requisite skills that enable them to exploit resources to their full potential. We examined several aspects of the teachers' backgrounds to see whether these were correlated with Internet use and perceived value—their technology experience and expertise, their own education and their teaching experience and professional leadership activities.

1. TECHNOLOGY BACKGROUND

a) HOW LONG HAVE THEY HAD A HOME COMPUTER AND MODEM?

We earlier presented the not-unexpected finding that teachers with Internet access at home were more likely to use the Internet in their teaching. Here we look at the issue of whether how long teachers have had a modem is associated with their valuation and use of the Internet. Our data show that teachers with a home modem, even those who have had one for a brief time, are more likely to make professional use of the Internet. On the other hand, only teachers with at least 3 years of home modem use are more likely to have students use the Internet and more likely to believe classroom Internet access is essential to their teaching. [TABLE 17]

TABLE 17: INTERNET USE/VALUE BY LENGTH OF TIME HAVING HOME MODEM

Home Computer & Modem	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Neither	.36	.13	.14	.05
Computer, no modem	.47	.15	.18	.04
Both, 1-2 yrs	.47	.23	.19	.04
Both, 3-5 yrs	.57	.28	.25	.08
Both, > 5 yrs	.61	.27	.27	.08

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC

b) SELF-REPORTED COMPUTER COMPETENCIES

Teachers were asked to assess their own current skills related to using computers. Six of the items were not specific to the Internet itself—simply questions about computer file handling, setting up database files, and using word-processors, presentation software, and hypermedia authoring programs. The seventh

item asked about their ability to use a Web search engine. Teachers who reported they could use a search engine (62% of all teachers) were compared with those who said they could not or could only use it "somewhat." Similarly, teachers with relatively high scores on an index combining the other six items (35% of all teachers) were compared with all other teachers.

Both general computer skills and the specific skill of being able to use a Web search engine are correlated with both teacher and student use of the Internet and with greater perceived value.
[TABLE 18]

TABLE 18: INTERNET USE/VALUE BY SELF-REPORTED COMPUTER SKILLS AND ABILITY TO USE WEB SEARCH ENGINE

Search Engine Skills	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
High computer skills	.60	.31	.29	.10
Low or average computer skills	.43	.16	.16	.03
Yes, can use search engine	.59	.28	.28	.08
No search engine skill	.32	.10	.07	.02

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Teachers with high computer skills or who said they could use an Internet search engine had an average Teacher Use and Student Research Use score of nearly .30, while those with average or low computer skills overall had scores averaging .16 and those who reported not having the ability to use an Internet search engine had scores averaging under .10.

c) DURATION OF COMPUTER USE WITH STUDENTS

Most teachers now use computers in some way with their students. However, some have been doing so for many years. It is reasonable to think that teachers who have been having their students use computers for several years would be more likely to use the Internet and to value its use than those with less experience with using computers in the classroom. However, our data show that the major difference in teachers' professional use and valuation of the Internet is between teachers who have never assigned computer work to students and those who have—regardless of how long they have been using computers with students. The duration of a teacher's use of computers with students makes almost no difference in average scores on teacher use, student research use or student use for projects and publication.
[TABLE 19]

TABLE 19: INTERNET USE/VALUE BY DURATION OF ASSIGNING COMPUTER TASKS TO STUDENTS

Duration of Computer Use with Students	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Never assigned	.33	.11	.04	.01
Assigned for 1-2 yrs	.49	.22	.24	.06
Assigned for 3 yrs+	.55	.24	.26	.07

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

2. PROFESSIONAL BACKGROUND

a) YEARS OF TEACHING EXPERIENCE AND AGE

Compared to most of the other predictors we have been examining, duration of teaching experience has a relatively small relationship to Internet use and valuation by teachers. However, those teachers in their first few years of teaching are somewhat different from other teachers. Even though they are younger and possibly more computer-savvy in general, the teachers with less than four years of teaching experience are slightly less likely than other teachers to use the Internet with students. However, their younger age makes them more comfortable with the Internet in terms of their own use. Teachers under age 30 in their first few years of teaching are the ones most likely to use the Internet professionally, and, overall, teachers under 30 are also more likely than older teachers to consider the Internet to be essential in their classroom. The teachers who are most likely to use projects and student Web publishing are those who have 4 to 7 years of teaching experience behind them. **[TABLE 20]**

TABLE 20: INTERNET USE/VALUE BY YEARS OF TEACHING EXPERIENCE AND AGE

Teaching Experience	Age Group	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
0-3 yrs	under 30	.57	.28	.17	.05
	31-50	.43	.21	.18	.05
4-7 yrs	under 30	.56	.22	.26	.07
	31-50	.48	.20	.21	.09
8-15 yrs	31-50	.50	.23	.21	.05
	over 50	.38	.19	.14	.04
16 yrs+	31-50	.48	.18	.22	.06
	over 50	.46	.19	.20	.04
Total	all	.49	.21	.20	.05

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

b) EDUCATIONAL BACKGROUND—GPA, COLLEGE ATTENDED, ADVANCED COURSEWORK

Several measures of educational background were examined to see how much of a difference they made, in combination, in predicting teacher Internet use and valuation. The background measures were (1) the teacher's undergraduate grade-point average (GPA), (2) the "selectivity" of the college the teacher attended as an undergraduate, (3) an index of units and degrees obtained beyond a BA, and (4) the number of courses outside of education taken since college.[6]

Our analysis of the relation between educational background and Internet use employed the statistical procedure of multiple linear regression. We summarize that analysis here in terms of two "typical" teachers representing differing educational backgrounds: Hypothetical Teacher A had an undergraduate GPA of 3.1 or lower, attended a college whose entering students scored an average of about 850 on the SATs (colleges such as Middle Tennessee State, Western Illinois University, or Bridgewater State

[6] Selectivity was measured by an index of test scores of entering freshmen in 1983, close to the median year for college entry for the teaching population as a whole. Scores were provided by the Higher Education Research Institute at UCLA.

College), and has not taken any courses outside of education since receiving the BA degree nor accumulated as much as 30 units of any university credit since the BA. Teacher B had a grade average 3.5 or higher, attended a school whose students averaged about 1100 on the SAT (such as U.C. San Diego, Villanova University, or New York University), has an MA degree plus 30 units beyond the MA, and has taken 10 courses outside of education since the BA. These two teachers, based on the linear prediction model used, show distinct differences in Internet use and valuation as shown in the accompanying table. **[TABLE 21A]**

TABLE 21A: INTERNET USE/VALUE BY TEACHER'S EDUCATIONAL BACKGROUND

Educational Background	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Teacher A (low)	.44	.15	.14	.04
Average for whole population	.48	.21	.20	.05
Teacher B (high)	.52	.28	.29	.08

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

TABLE 21B: PREDICTION OF INTERNET USE/VALUE FROM EDUCATIONAL BACKGROUND MEASURES (STANDARDIZED BETA COEFFICIENTS)

Educational Background Measure	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Undergraduate GPA	.02	.08	.04	.01
College Selectivity	-.03	.04	.08	.08
Units and degrees beyond BA	.07	.05	.02	.01
Non-Education courses beyond BA	.03	.01	.06	.04
Multiple Correlation (R)	.08	.11	.12	.10

Note: Selectivity was measured by an index of entering freshmen test scores in 1983, a "typical" year for the teaching population as a whole. Scores were provided by the Higher Education Research Institute at UCLA.
Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

In general, Teacher A, suggesting a teacher with relatively limited educational experiences, is less sure of the need for the Internet in her classroom and is perhaps half as likely to use it herself or with students as Teacher B, who represents a teacher with extensive educational experiences. All four of the educational background measures contributed to the differences between Teacher A and Teacher B, but generally only one measure made a sizable difference for each outcome. The largest effect on predicting use of the Internet with students comes from selectivity of the college attended. The teacher's own success in school (i.e., GPA) made the biggest difference in predicting their own use of the Internet. Advanced degrees and coursework contributed the most of any measure for predicting the teacher's judgment of the value of the Internet for classroom teaching.

c) PROFESSIONAL LEADERSHIP ACTIVITIES

The teaching profession is generally regarded as having a very flat hierarchy. Each teacher works independently to plan and direct the learning of their own class. This planning occurs with only occasional input from supervisors or colleagues. However, the profession is increasingly recognizing that teachers can become better at their craft when many in their profession engage in peer leadership activities—for example, by mentoring less experienced teachers, leading workshops for disseminating

new ideas, or writing and publishing for other teachers. Do teachers who become involved in leadership activities of this sort also use the Internet more in their professional work? Do they necessarily use the Internet more with students in their teaching? Are they more likely to regard it as an essential part of an effective classroom?

We measured a teacher's involvement in leadership activities by asking respondents to report which of six types of activities they had engaged in during the previous three years, if any: informally mentoring a teacher for most of a year, having a formal mentoring relationship with a teacher, giving a workshop or conference talk for at least 25 teachers, giving workshops on at least five occasions, teaching a college-level course for credit; or publishing an article in a magazine or journal for professional educators. Although 60% of teachers have done one or more of these things in the past three years, only 20% have engaged in at least three of these six leadership activities.

Table 22 shows that these teacher leaders are much more likely to use the Internet than other teachers, both in their own professional activities (mean scores of .29 vs. .19) and in terms of using them with students (for example, in research activities, the differences are .30 vs. .18).

TABLE 22: INTERNET USE/VALUE BY PROFESSIONAL LEADERSHIP ACTIVITIES

Professional Leadership Activities	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Few or none	.46	.19	.18	.04
Many	.59	.29	.30	.10

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

D. SCHOOL SUPPORT FOR TEACHING USING TECHNOLOGY

Even though software developers have been conscious of the need to make their programs easy for teachers to learn and to use, the power and flexibility of most computer applications inevitably requires teachers master new skills before they can become expert users of computer resources. The new understandings required of teachers include not only technical skills but an understanding of the relevance of the various features and information provided by the software to their own instructional and curricular priorities, as well as pedagogical strategies for using the software in the context of other constraints, such as time limitations and prerequisite student skills. To accomplish those understandings, many schools provide formal staff development for teachers on computer skills; and some facilitate informal contact among teachers so that the understandings may spread in the normal course of their professional interactions. Our data explored the relationship of both of these processes to teacher Internet use and related beliefs.

1. FORMAL STAFF DEVELOPMENT

Three out of ten teachers report having attended a workshop or other formal staff development activity in the past year in which "how to use the Internet" or other on-line activities was a central topic of discussion. Teachers who attended such staff development activities were more likely to believe the Internet to be an essential classroom resource and more likely to use the Internet than other teachers, by a fairly large degree. **[TABLE 23]**

TABLE 23: INTERNET USE/VALUE BY STAFF DEVELOPMENT ATTENDANCE, CONTROLLING ON INTERNET ACCESS

Internet Access	Staff Development	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Both home and classroom	Non-attenders	.63	.31	.35	.09
	Attenders	.72	.41	.47	.15
Classroom only	Non-attenders	.50	.24	.31	.09
	Attenders	.57	.22	.33	.08
Home only	Non-attenders	.42	.18	.11	.02
	Attenders	.55	.23	.12	.04
Neither	Non-attenders	.30	.07	.05	.01
	Attenders	.46	.10	.13	.05
All	Non-attenders	.43	.17	.16	.04
	Attenders	.61	.28	.31	.09

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Nevertheless, one could argue that teachers who were more interested in using the Internet participated in this staff development in the first place. To partly control for prior interest and motivation to attend, we looked only among teachers who had the same level of Internet access (for example, they had it at home but not in their classroom). Table 23 shows that even among teachers with the same access at home and in their classroom, teachers who attended staff development on the Internet were somewhat more likely to use it in their teaching and for professional work. The "staff development effect," at least as modeled so far, seems to be most clearly present for teachers who have access both at home and in their classroom, or for those without access in either place. For example, among teachers who had access in both places, the average Teacher Internet Use score for teachers who attended staff development was .41; but for those who did not attend such training, only .31.

2. INFORMAL CONTACTS AMONG TEACHERS

Each teacher was asked how frequently they had had several types of discussions with other teachers at their school—discussions about how to teach a concept; of ideas for student or group projects; discussions about computers, software, or the Internet; about personal matters; and about issues in their subject-matter field—and they were also asked about the frequency that they observed another teacher's class or another teacher observed herself. Note that in contrast to our measure of formal staff development, only a small part of our measure of informal contacts dealt with conversation about the Internet per se. Instead, it is a measure of the breadth of conversation that occurs among teachers at the same school.

We divided teachers into four quartiles in terms of the overall frequency of informal contacts. We found that there were clear distinctions in Internet use between each quartile—the higher the frequency of informal contacts, the greater the use of the Internet and the more essential its presence was regarded. **[TABLE 24]**

TABLE 24: INTERNET USE/VALUE BY FREQUENCY OF INFORMAL CONTACTS, CONTROLLING ON INTERNET ACCESS

Internet Access	Informal Contacts	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Both home and classroom	Remaining Quartiles	.62	.31	.38	.09
	Top Quartile	.81	.48	.47	.18
Classroom only	Remaining Quartiles	.52	.22	.33	.08
	Top Quartile	.55	.26	.31	.13
Home only	Remaining Quartiles	.42	.16	.11	.02
	Top Quartile	.55	.31	.12	.04
Neither	Remaining Quartiles	.30	.06	.05	.01
	Top Quartile	.49	.16	.10	.03
All	Remaining Quartiles	.44	.17	.18	.04
	Top Quartile	.63	.33	.27	.09

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

When we controlled on Internet access at home and in the classroom, to look at the relationship between Internet use and informal contacts independent of issues of access, we found that the differences between high-contact teachers and other teachers was more substantial and more widespread than the differences between in-service attenders and non-attenders. This was particularly true for the differences between teachers who were in the top quartile of informal contacts and teachers in the three other quartiles. [See Table 24.] So for example, among teachers without any Internet access, either at home or in their classroom, teachers who had frequent informal contact with other teachers were more likely to use the Internet themselves (.16) and to believe it was essential for classroom teaching (.49) than other teachers that also lacked Internet access but who didn't have that high level of informal contact with other teachers (.06 and .30, in comparison).

3. SCHOOL-PROVIDED COMPUTER RESOURCES

Having a computer on one's own desk may be another element in the support structure for facilitating a teacher's use of technology. Our data show that teachers who report that their school provided them with their own computer are more likely to believe that classroom Internet is essential to teaching, and are more likely to use the Internet as well. However, once we control on whether their classroom had Internet access, only the difference in attitudes remains. In other words, among teachers with the same level of Internet access in their classroom, those who have been provided with a computer for their own professional use are more likely to believe classroom Internet access to be essential. However, they are no more likely to use the Internet in their teaching (either themselves or by their students) than are teachers who were not given a computer for themselves. **[TABLE 25]**

TABLE 25: INTERNET USE/VALUE BY WHETHER SCHOOL PROVIDED THE TEACHER WITH A COMPUTER, CONTROLLING ON CLASSROOM INTERNET CONNECTIVITY

Classroom Internet Connectivity	Did School Provide Teacher with Computer?*	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
None	No	.35	.14	.10	.01
	Yes	.45	.14	.08	.03
Modem	No	.53	.32	.34	.09
	Yes	.63	.29	.33	.11
Direct-LAN	No	.54	.34	.42	.11
	Yes	.64	.34	.43	.11
All levels of connectivity	No	.37	.16	.14	.03
	Yes	.55	.23	.24	.07

* Either a desktop or laptop computer provided for the teacher at his own desk.
Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

E. PEDAGOGICAL BELIEFS AND PRACTICES

Along with other applications of computers, the Internet has been seen by many people as a vehicle for teachers to carry out major changes in how they teach students. Obviously, having students use the Internet is by itself one level of change—a change in the information resources that students examine. But it may also be that the Internet enables teachers to follow a whole new approach to teaching based on a different theory of how students attain understanding or new perspectives on what it is important for students to know.

In the common view of the teaching-learning model, the teacher helps students to master a sequential set of skills, facts, and concepts primarily by (a) having the whole class read the same material in a textbook, (b) explaining the content to students using various forms of questioning and direct explanation, and (c) having students practice their understanding repetitively until they can demonstrate their competency on a test. In contrast, a "reform" or "constructivist" approach to teaching involves having students work on complex projects, often in groups, and often with different groups working on different projects. In this model, students learn skills and concepts in the context of using them to do something—for example, in making a product. These projects follow from a constructivist theory of learning that suggests that subject-matter becomes meaningful, and therefore understandable, only when it is used in context-rich activities. Teachers whose instructional plan follows from constructivist learning theory will not only use group projects more than other teachers; they will, for example, emphasize the student's own responsibility for designing their own tasks, for figuring out their own methods of solving problems, and for assessing their own work—all as a means of making learning tasks more meaningful to students.

1. MEASUREMENT OF CONSTRUCTIVIST PEDAGOGY

A number of multi-part questions in the teachers' survey asked teachers about their beliefs of what constitutes good teaching and about how they carry out instruction in one of their classes, in particular, in the class "where you are most satisfied with your teaching—where you accomplish your teaching goals most often." Factor analysis was used to select a subset of items that contributed to measures of the underlying conceptual contrast between constructivist and traditional pedagogies. Although different factor analyses yielded slightly different sets of items, the one used here incorporates 11 "belief" items (i.e., assessments of the value of different teaching practices) and 15 "practice" items (i.e., reports of the

frequency they used different methods). This particular factor analysis distinguished five "factors" related to constructivist versus traditional pedagogy:

- **Disagreement with traditional pedagogy and learning theory**: opposition to statements about the value of (1) a quiet classroom; (2) basic skills being taught prior to "meaningful" instruction; (3) teacher control over the classroom agenda; (4) problems or tasks with clear correct answers; (5) teacher explanations to students based on their superior knowledge; and (6) learning being dependent on a store of background knowledge.

- **Agreement with statements about a the value of...** (1) the teacher being a facilitator rather than explainer; (2) multiple classroom activities rather than a common set for all students; (3) interest and effort being more important than the particular subject-matter in the prescribed curriculum; (4) student participation in setting assessment criteria; and (5) student freedom of movement within a classroom.

- **Frequent use of projects and demonstrations**: (1) demonstrating their work to an audience; (2) making a product to be used by someone else; (3) working on projects that take a week or more; (4) doing "hands-on" collaborative activities; and (5) NOT working individually to answer questions (i.e., seatwork).

- **Frequent practices requiring heavier student responsibility**: (1) deciding on their own procedures for solving a problem; (2) designing their own problems to solve; (3) work in small groups to come up with a joint solution; and (4) doing problems with no obvious solution.

- **Frequently using the following practices in their teaching**: (1) student assessment of their own work; (2) student essay-writing; (3) student journal-writing; (4) student debates; (5) assignments for which "there is no correct answer; and (6) student participation in planning class activities.

Although all five of those "factors" are independent of each other (and thus statistically uncorrelated, a result of the factor analysis procedure), for this report we used the information provided by the factor analysis in a heuristic manner. In particular, we combined the teachers' responses on the 26 items that loaded on any one of the five factors into an overall index of constructivist pedagogy. Those constructivist pedagogy scores were then correlated with Internet use.

Overall, the "typical" teacher is almost right in the middle between the "constructivist" and the "traditional" ends of the index, scoring 2.9 on a scale whose maximum (constructivist pole) is 5 and whose minimum (traditional pole) is 1.[7]

[7] The study of teacher pedagogy is a central part of the TLC-1998 research. Later reports will discuss pedagogical differences among different groups of teachers, and will provide data on specific aspects of teachers' beliefs and practices. Those various aspects are combined here for this initial examination of the relationship between constructivist pedagogy and use of the Internet.

2. CONSTRUCTIVISM AND INTERNET USE

The responding teachers were divided into four quartiles based on their "constructivist vs. traditional pedagogy" index score. On all four measures of Internet use and valuation, the more constructivist the teacher the greater their average use and the more positively they viewed the Internet. **[TABLE 26]**

TABLE 26: INTERNET USE/VALUE BY CONSTRUCTIVIST VS. TRADITIONAL PEDAGOGY

Teacher's Pedagogy	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Most traditional (22%)	.34	.12	.11	.02
More traditional than constructivist (31%)	.43	.17	.16	.04
More constructivist than traditional (29%)	.54	.25	.25	.07
Most constructivist (19%)	.65	.30	.31	.09

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

For example, among the most constructivist teachers (those in the upper 19% on the index) nearly two-thirds (65%) believed Internet presence in their classroom was essential; among the most traditional teachers, only one-third (34%) felt it was essential. Similarly, the most constructivist teachers' average score for Teacher Internet Use was 2 1/2 times as high as the average score for the most traditional teachers (.30 vs. .12). Differences in terms of teachers' use of the Internet with their students was even greater: The average Student Research score for the most constructivist teachers was .31, compared to .11 for the most traditional teachers; and in terms of Student Projects and Publication, the respective averages were .09 versus .02. Clearly, a teacher's pedagogical beliefs and practices are strongly related to how relevant they see the Internet for their teaching and whether they use it.

PART V. MULTIVARIATE ANALYSIS

So far we have shown that almost every variable we have examined, has at least some relationship to whether teachers use the Internet and whether they regard its presence in their classroom as essential to their teaching. These variables include...

INTERNET ACCESS
- Classroom Internet access
- Home Internet access
- Direct-LAN connectivity in their classroom
- Having many computers in the classroom with simultaneous Internet access

TEACHING RESPONSIBILITIES
- Subject-matter responsibilities and school level
- Prior achievement of students taught

TECHNOLOGY EXPERIENCE
- Whether they have used computers with students
- How long they had had a modem at home
- Self-reported computer competencies

PROFESSIONAL EXPERIENCE

Years of teaching experience and age
Educational background: college attended, GPA, courses and degrees since BA
Professional leadership activities

SCHOOL SUPPORT FOR TEACHING USING TECHNOLOGY

Formal training on Internet use
Informal contacts among teachers on a variety of topics
Whether the school has supplied them with a computer on their desk

PEDAGOGICAL BELIEFS AND PRACTICES

Constructivist vs. traditional pedagogical beliefs and practices

In Part V, we address two related questions:

A. To what extent do these variables in combination account for variation among teachers in their Internet use and valuation? That is, if we take into account all of the variation among teachers and in their teaching context represented by the above list of variables, how different do teachers look from one another in terms of Internet use?

B. Which variables are most strongly related to Internet use and beliefs about its value, net of all other predictor variables? We add that last phrase, "net of the other predictor variables," because some of these predictor variables are themselves correlated. For example, teachers employing constructivist pedagogies were also more involved in professional leadership activities and had more informal contacts with other teachers. Therefore, taking a somewhat conservative approach, we ask what is the contribution of each variable in predicting teacher Internet use and value, once each of the other variables is accounted for.

A. ALL PREDICTORS CONSIDERED TOGETHER

To measure the combined force of Internet access, teaching responsibilities, technology expertise, professional experience, school support for teaching, and pedagogical beliefs and practices on teachers' Internet use and valuation, we established a set of criteria or conditions, one for each variable, and then calculated for each teacher how many of the conditions were present for that teacher. Specifically, we used the following twenty conditions:

INTERNET ACCESS

Had classroom Internet access of some kind
Had direct-LAN connectivity in their classroom
Had Internet access at home

TEACHING RESPONSIBILITIES

Computer class teacher
NOT a math teacher
Taught high achieving classes

TECHNOLOGY EXPERTISE

Had used computers with students
Had a modem at home for 3 years+
Broad computer expertise

PROFESSIONAL EXPERIENCE

Under 30 years of age
Teaching experience: 7 or less
Educational background:
College GPA: 3.5+
Attended a selective college (SAT 1100+)
Masters degree or higher
Coursework since BA: 8+ courses outside education
Professional leadership activities: 3+ out of 6

SCHOOL SUPPORT FOR TEACHING

Formal training on Internet use in the last year
Had frequent informal contacts with other teachers at school
School provided teacher with computer

PEDAGOGICAL BELIEFS AND PRACTICES

Constructivist pedagogy (top 19% on index)

In the case of the typical (median) teacher, seven of these twenty conditions are present. However, for some teachers as many as sixteen conditions are present, and a few teachers have just one or two. The effect of the combination of all of these predictors on teachers' use and valuation of the Internet is dramatic as can be seen in Figure 27 and, in more detail, in Table 27. **[FIGURE 27]** & **[TABLE 27]**

FIGURE 27: INTERNET USE/VALUE BY NUMBER OF CONDITIONS PRESENT

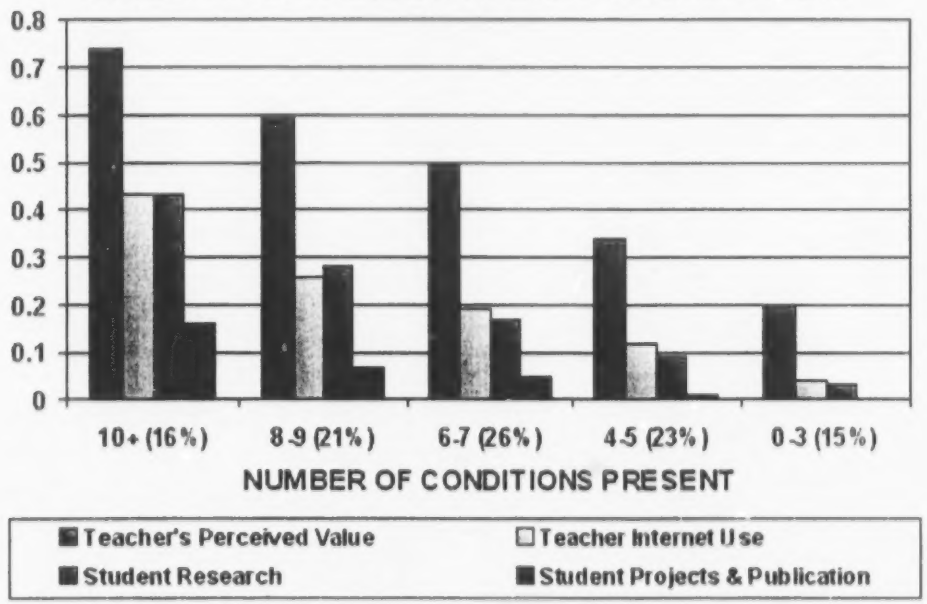


TABLE 27: INTERNET USE/VALUE
BY NUMBER OF PREDICTIVE CONDITIONS PRESENT IN THEIR CASE

Number of Conditions Present	% of all teachers	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
0-2	4.9	.20	.02	.02	.00
3	9.3	.20	.06	.04	.00
4	10.0	.34	.12	.10	.02
5	13.0	.35	.11	.09	.01
6	10.1	.43	.17	.13	.03
7	15.7	.55	.21	.20	.06
8	11.5	.53	.23	.25	.06
9	9.5	.68	.28	.31	.07
10	7.0	.67	.36	.36	.14
11	4.6	.76	.41	.41	.10
12-20	4.5	.82	.56	.57	.25
Total	100.0	.48	.21	.20	.05

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

Nearly every increase in the number of conditions present is accompanied by an increase in teachers' Internet use and valuation. Whereas the 15% of teachers with the fewest criteria have Perceived Value scores averaging .20 (20% believing the Internet is essential in their classroom), those passing at least half of the criteria have Perceived Value scores averaging .74 (74%). Similarly, our measure of a teacher's professional use of the Internet rises from .04 to .43, Student Research use goes from .03 to .43, and Student Projects and Publications increases from .00 to .16. Those few teachers meeting 12 or more criteria (4.4% of all teachers) have even higher scores, with, for example, an average Student Projects and Publication score of .25 and an average Student Research use score of .57.

There are several ways to think about the results in Table 27. From one perspective, even among teachers with many things in their favor—perhaps a good educational background, good Internet access, school support for using technology, and some expertise in using computers—only about one-half of the teachers in the most favorable settings are strong Internet users or use the Internet in a substantial way with students. At most, only one-fourth of them involve classes in cross-school Internet collaborations or put up student work on the World Wide Web. On the other hand, in the absence of those conditions very few teachers are Internet users, and where fewer than one-half of these conditions apply very few teachers use the Internet for student projects and publication. It is important to remember, though, that the Internet is a brand-new resource in most schools. Over time, one would expect all of the cells in Table 27 to contain higher and higher numbers. However, the differences in average scores for teachers experiencing different conditions may stay relatively constant.

C. MULTIVARIATE ANALYSIS – THE FACTORS THAT MOST DIFFERENTIATE USERS AND NON-USERS

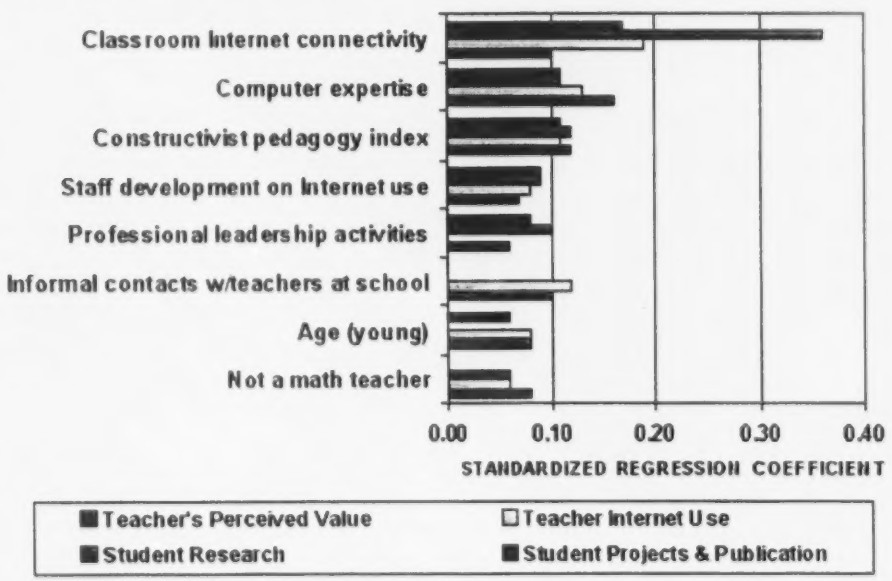
The previous section answered the question, "How much difference does the full set of conditions make in the likelihood of a teacher being an Internet user?" Here we address the question of which conditions make the most difference. We are essentially applying a common metric to all of the different results presented in Part IV. However, we are also taking into account the overlap that exists among multiple predictors. In other words, we are taking into account the fact that different predictors are themselves correlated. (For example, teachers who participate in formal staff development activities about the Internet are more likely to have classroom Internet access, with a measured correlation of $r=.30$.)

As a first step in this effort to reach an understanding of the "causal" influences on a teacher's becoming an Internet user, we applied standard multiple linear regression techniques to our data. We used the original "interval-level" measures of each predictor rather than the simpler dichotomies that were used in the previous analysis. In other words, rather than measuring Teacher's Informal Contacts by the simple contrast of whether or not a teacher was in the top quartile on that index, we used the original index scores for each teacher, which varied from 1.00 to 4.00 with many different fractional scores in-between. Our measure of the "independent effect" of a predictor variable is the standardized beta coefficient in the regression equation. Four equations were used, one for each outcome variable. All relationships discussed are statistically significant at $p<.05$ and meet an "effect size" criterion of the standardized beta coefficient being greater than .05.[8]

Out of the 18 variables examined in the multiple regression equation **[TABLE 28]**, eight of them have important independent relationships to teachers' Internet use and valuation outcomes:

- Level of classroom connectivity
- Teacher's computer expertise
- Constructivist pedagogy
- Participation in staff development on Internet use
- Involvement in professional leadership activities
- Having informal contacts with other teachers at their school
- The teacher's age (the younger, the more likely using and believing in its value)
- Not being a mathematics teacher. **[FIGURE 28]**

FIGURE 28: MOST SIGNIFICANT PREDICTIVE CONDITIONS OF INTERNET USE/VALUE



[8] Multiple regression analysis measures only "direct" relationships between a predictor variable and an outcome, controlling on all other inputs. Consequently, predictors that operate through other predictors in the equation are not given "credit" for their "indirect" contribution to the outcome through affecting such an intermediary (intervening) variable. For example, educational background may influence Internet use through its affect on Professional Leadership. However, in multiple regression only the effects not mediated by professional leadership or other intervening variables remain attributed to educational background. Subsequent analysis will employ path analysis to more accurately model the distinction between prior and intervening variables, and direct and indirect effects.

TABLE 28: CONDITIONS ORDERED BY THE DEGREE TO WHICH THEY PREDICT LEVELS OF INTERNET USE/VALUE

	Teacher's Perceived Value	Teacher Internet Use	Student Research	Student Projects & Publication
Classroom Internet connectivity	.10	.19	.36	.17
Computer expertise	.16	.13	.11	.11
Constructivist pedagogy index	.12	.11	.12	.11
Staff development on Internet use	.07	.08	.09	.09
Professional leadership activities	.06		.10	.08
Informal contacts w/teachers at school	.10	.12		
Age (negative) (i.e., being young)	.08	.08		.06
Not a math teacher	.08	.06	.06	
Home Internet access		.10		
School provided computer for teacher	.08			
Advanced degree & units	.07			
Selectivity of college attended	-.07			
Computer teacher			.06	.06
Classes' prior achievement level				.06
Whether used computers w/students	.05		[a]	[a]
College grades (GPA)				
Years of teaching experience				
Courses outside of Education since college				
R-squared (percent of variance explained)	19%	23%	26%	14%

Note: Only coefficients above 0.05 are shown.
[a] Not included in regression equations for student use – tautological.
Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," http://www.crito.uci.edu/TLC.

1. THE MAJOR THREE PREDICTORS: CONNECTIVITY, COMPUTER EXPERTISE, & CONSTRUCTIVIST PEDAGOGY

By far the most important variable in predicting teachers' Internet use is **the teacher's level of classroom connectivity**. This variable takes on four values: no connection (0); modem connection (1); direct connection (2); direct connection with four or more computers present (3). The beta coefficients for Level of Classroom Connectivity ranged from .10, for Teacher-Perceived Value, to .36, for use in Student Research. As schools move towards connecting more classrooms to the Internet, particularly with high-speed direct connections, we can foresee parallel increases in the number of teachers who make regular use of the Internet, particularly for student research, but also for their own class preparation and for student cross-classroom projects and Web publication. For all three Internet use outcomes (but NOT for "teacher's perceived value"), classroom connectivity level had the strongest relationship of any of the predictors examined.

Other analyses performed, but not shown in Table 28, separated out which aspect of connectivity is most related to Internet use—any connection at all; high-speed direct connectivity; or connectivity with many computers attached. For all four outcome variables, the biggest effect comes from having any classroom connection at all, rather than having to connect elsewhere in the school building or at home. However, both direct connectivity and direct connectivity with multiple (4+) computers contributed to explaining variation in teacher-directed Student Research use (beta coefficients of .07 and .08 respectively, in the full regression model). In addition, direct connectivity had an independent effect on teacher's professional use of the Internet (beta = .07), and direct connectivity with four or more computers had a small effect on

the Student Projects and Publication variable (beta = .04). Overall, the effects of "any classroom access" were stronger than these other connectivity aspects. However, it should be recalled that the measurement of connectivity level was subject to substantial ambiguity and imputation; the result will be to underestimate the effects of direct connectivity on all of the outcome variables.

Two other predictors were also related to all four Internet use and valuation outcomes with standardized beta coefficients of +.10 or higher: the teacher's computer expertise and the teacher's pedagogical beliefs and practices.

Teacher computer expertise had the strongest association of any predictor on the "valuation" outcome—i.e., affecting how likely a teacher was to say that classroom Internet resources (e-mail and Web) were essential to good teaching. Computer expertise was measured here by excluding Internet-specific skills such as using a World Wide Web search engine, so it is simply a teacher's overall computer expertise (self-reported) that predicts beliefs about the value of the Internet for their classroom teaching. Computer expertise also predicted teachers' professional use of the Internet better than any variable besides classroom connectivity level. Thus, although the Internet is often presented as a novice-friendly area of computer use, it seems that here as well, relevant prior computer knowledge may be an important pre-requisite for a teacher to make the Internet a valued resource in their classroom, and valuable in their lesson preparation activities in particular.

The third major predictor of teachers' Internet use and valuation in this analysis is the **teacher's pedagogical beliefs and practices**. Our index contrasting constructivist-compatible teaching pedagogy with traditional fact- and skills-based teaching had beta-coefficients above .10 for all four outcome variables. One conclusion of this finding is that scaling up Internet use to higher numbers of teachers may depend in part on changing the relevance that teachers perceive the Internet holding for their primary instructional goals—which in turn may require changing teachers' instructional priorities. Teachers who regard education as primarily the distribution of facts and skills to students according to a fixed curriculum sequence are much less likely to exploit the Internet than more "constructivist" teachers.

2. SCHOOL-BASED SUPPORT, LEADERSHIP EXPERIENCE, HOME ACCESS

Besides the three variables just discussed—classroom connectivity level, computer expertise, and constructivist vs. traditional pedagogy—other predictors had modestly strong beta coefficients for one or two outcome variables, but not across all outcomes. The level of a teacher's **informal contact with other teachers at their school** was associated with more positive beliefs in the Internet's value in the classroom and with a greater likelihood of using the Internet for professional tasks (beta equal to .10 and .12, respectively). However, informal contact (i.e., discussions with other teachers on a variety of topics; and mutual classroom visits) was not substantially related to student Internet use, once other predictors were taken into account. Similarly, a **teacher's home Internet access** was an important predictor of a teacher's professional use of the Internet, but not so for student use. In contrast, **involvement in professional leadership activities** was an independent predictor of student Internet use but not so much of teacher use or attitudes, once other predictor variables were controlled.

Participating in **staff development activities related to using the Internet** had positive beta coefficients on all four outcomes, but the coefficients were slightly weaker than those discussed so far.
It is not clear whether much should be made of the pattern in the above two paragraphs—e.g., that professional leadership is not associated with teacher professional use of the Internet, while the frequency of informal collegial relationships is not associated with more student Internet use, net of other predictors. Teachers who are active professional leaders—who mentor other teachers, do workshop presentations,

and possibly even write or teach professionally—certainly do use the Internet more than other teachers do; however, the beta coefficient predicting "Teacher Internet Use" was just under the .06 criterion used for inclusion in Table 28. Second, although a mix of informal relationships among teachers may create a climate in which teachers take the effort to become Internet users themselves, it may be that for teachers to use the Internet with students only more specific computer-specific communication makes a difference. In fact, when we substitute for the full index of informal contact just a single measure of how frequently they discuss "computers, software, or the Internet" with other teachers, the beta coefficient was high enough (.08) to have enabled "Informal Contacts" to be represented in the Student Research Use column of Table 28.

3. AGE AND SUBJECT TAUGHT

Moving on to the remaining predictors in Figure 28, we find that the **younger the age of a teacher** the more likely the teacher was to use the Internet herself or with students, and the more she believed the Internet had an essential role in her classroom. Thus, the greater comfort with technology that younger teachers display outweighs advantages of greater teaching experience. In addition, **mathematics teachers** were clearly distinct from all other teachers in their lower likelihood of Internet use and in their lack of belief that Internet resources were "essential" to their classroom teaching. Also, there was a slightly higher likelihood for **teachers of computer classes** to be involved in having students use the Internet, after other predictors, such as level of connectivity and pedagogical beliefs, were taken into account.

4. EDUCATIONAL BACKGROUND, SCHOOL-SUPPLIED COMPUTER: RELATIONSHIPS EXPLAINED BY INTERVENING VARIABLES

If these were the variables that appeared to make a difference in discriminating among teachers in their Internet use and valuation, which variables did not. Generally speaking, once other variables were held constant, the teachers' own educational background did not have an independent effect on Internet use (but it did, still, on how much the teacher valued the Internet). However, the lack of an effect here is likely to mean only that the effect of educational background on Internet use (shown earlier in Table 20) is mediated by certain intervening variables in the model, such as leadership participation or computer expertise. In other words, teachers with a more educationally advantaged background (higher degrees, higher grades, more selective schools) were more likely to undertake leadership activities within the profession and more likely to obtain computer expertise. When those intervening variables are "held constant," they "explain away" the original relationship between educational background and Internet use. Similarly, the association between a teacher's Internet use and a school's providing that teacher with her own desktop computer (shown in Table 25) evaporated in the multiple regression model. Again, however, it may be that the effect of having their own school-supplied computer is "hidden by co-linearity with" (occurring to the same individuals as) high levels of classroom connectivity. However, even taking connectivity into account, teachers with a school-provided desktop computer were more likely to believe it was essential to their classroom teaching.

OTHER NEGLIGIBLE EFFECTS

In contrast to the variables discussed so far, there is relatively little effect of prior computer experience on teachers' professional use of the Internet. (This variable was excluded from the regression equations predicting student use, since, by definition, teachers who have not used computers with students have not had students use the Internet either.) Moreover, as shown earlier, how long a teacher had been having students use computers was not sufficiently predictive in the bi-variate analysis to even include that variable in these multiple regression analyses.

Finally, student ability, or prior achievement as we have called it here, was not a predictor of teacher Internet use. Teachers with both high ability classes were roughly equally likely as other teachers to use the Internet with students. The only hint of a difference was in terms of Student Projects and Publications, where teachers of high ability classes were slightly more likely to use the Internet in this way than were other teachers, net of other factors.

PART VI. CONCLUSIONS

Along with word processing, the Internet may be the most valuable of the many computer technologies available to teachers and students. In its first few years of existence, the World Wide Web has become one of the most frequently used computer technologies in schools. In addition, hundreds of thousands of teachers have become regular electronic mail users, although that same degree of taken-for-granted access has not yet been provided to many students. It is clear that, even in its most obvious manifestation as "the world's largest library," teachers find the Internet to be an incredibly useful technology. Moreover, current applications only scratch the surface of the capabilities that the world-wide digital communications infrastructure will eventually provide for teachers and their students.

In thinking about how to extend Internet use to larger numbers of teachers, it is useful to examine the conditions that our research identified as most consistently facilitative of greater levels of use—high levels of classroom connectivity; computer expertise; constructivist pedagogy; participation in staff development; high frequency of informal contacts with other teachers; involvement in professional leadership activities; being a young teacher; and not being a mathematics teacher.

Some of these conditions tell us the kinds of teachers that are most likely (or in the case of math teachers, least likely) to be drawn to the Internet—(1) younger teachers, (2) teachers who are leaders in their profession, and (3) teachers with constructivist pedagogies.

The importance of "age" may diminish over time. What makes young teachers more likely to be Internet users is not their youth per se, but their greater comfort as a result of having grown up with ever-changing computer technologies.

Second, the relationship between Internet use and professional leadership suggests that if leaders among teachers can be encouraged to share their enthusiasm and knowledge of the Internet with other teachers, this will also have an effect of diffusing use more broadly within the profession.

The pedagogy variable may be more intractable. Other research we are conducting[9] suggests that computer technology is having an emancipating effect on teachers who believe in project-based teaching and other constructivist-compatible practices. However, changing <u>other</u> teachers' philosophies and beliefs to be more constructivist simply by having them use computers in their teaching may not work. It may

[9] See Becker and Ravitz, Journal of Research on Computing in Education, Summer, 1999; and Dexter, Anderson, and Becker, Journal of Research on Computing in Education, Spring, 1999.

be, then, that diffusion of Internet use to larger numbers of teachers will reach a barrier when most of the remaining non-participants hold beliefs that are not as compatible with Internet use as constructivism seems to be—in other words, teachers who believe in a skills-based curriculum, organized in a fixed, externally-determined sequence, and who teach a uniform aggregation of content which all students should master.

The remaining variables related to Internet use are all, theoretically at least, within the reach of educational leaders to do something about. Certainly schools will increase the proportion of Internet-using teachers by increasing the level of classroom-located Internet connectivity—by establishing connections for classrooms that do not now have them, by having those connections be LAN-based, high-speed links, and by having at least several Internet-linked computers in each classroom. Our results about the importance of classroom-located connections suggest that schools will not increase teacher use or satisfaction with the Internet by limiting linkages to computer labs external to classrooms.
Building up the computer expertise of teachers also may produce greater use of the Internet; as would more training for teachers in how to use the Internet. However, it is the remaining "condition" in our list that is the most intriguing—frequent informal contact with other teachers at their school. As discussed earlier, teachers who use the Internet professionally report that, on average, they more frequently talk with other teachers at their school about how to teach a particular concept to a class, or about ideas for group projects, or even about personal matters, and they are more likely to have other teachers observe their own teaching. Although these differences don't extend to directly influencing student Internet use, net of other factors, frequent informal interactions among teachers may help teachers to learn enough about the Internet to apply it in their teaching in a variety of ways. The Internet thus becomes a potentially important tool in the creation of a collaborative professional culture among the teachers of a school.[10]

These findings do not represent the final word on determinants of teacher Internet use in 1998, or even the final word for this research project. Further analysis will show, for example, how the level of support for technology provided by a school (e.g., in technical troubleshooting, instructional support, and student supervision) relates to teachers' use of the Internet. The path analysis to be done will also take a second look at "distal" variables like teachers' educational background and examine how they affect eventual teacher Internet use.

[10] This paper has not examined the value of having teachers or students use the Internet, compared to other ways of learning or of being productive. Instead, we have taken as a starting point that use of the Internet is a worthwhile activity, and looked at the extent to which teachers are using this new technology and the conditions that make that use more likely.

APPENDIX A – SUMMARY OF STUDY METHODOLOGY

Teaching, Learning, and Computing surveyed teachers from a national probability sample of schools and from two targeted samples of schools--high-end technology-using schools and schools that participate (or where one or more teachers participate) in 52 identified national and regional educational reform programs. In both the probability sample of schools and the purposive samples, the teachers selected were a combination of a probability sample and a purposive sample of teachers who are either participants in reform programs or designated by their principal as exemplary users of constructivist/cognitive approaches.

The research began in the Spring of 1997 with a validation study of self-report measures of teacher beliefs and practices and exploratory studies of survey measures of changes in teaching practices and technology use and school-level investments in technology hardware, software, and training and teacher support. The validation study provided self-report data from 72 teachers in 24 schools and detailed classroom observation and interview data with those same teachers. At the school level, pilot versions of surveys were used in order to test measurement approaches for studying technology expenditure information, hardware and software acquisition, and investments of time and money in teacher training and support activities.

The data collection itself was the second stage of the project, taking place from January through June of this year, and conducted by the Battelle Centers for Evaluation and Health Research. Data collection encompassed an initial district contact information letter, followed by a school mailing, in which teachers were rostered and sampled; a subsequent mailing of questionnaires for teachers, the school-level technology coordinator, and the principal; and several waves of mail and telephone followup, editing, coding, data entry, and data cleaning. The teacher respondents were asked to complete a survey booklet about their teaching practice and teaching beliefs that was 21 pages in length and required approximately 60-75 minutes. Four different versions of the teacher survey booklet were used, with overlapping sets of questions. The school technology coordinator's booklet was approximately the same length as the teacher survey and principally concerned the investments their school has made in computer hardware, software, and teacher training and support, measured both financially and in units of time, materials, and equipment. The principal's survey booklet was half as long, and inquired about technology-related school policies and efforts in school restructuring and reform.

The third stage of the project involves data analysis, preparation of reports, and the release of national data files for secondary analysis.

SELECTION OF SCHOOLS

The national probability sample of schools consists of 898 public, private, and parochial schools selected from a national database of 109,000 schools supplied by the firm of Quality Education Data (QED) of Denver, CO, a marketing information division of Peterson's Guides. Schools were sampled according to their size (estimated number of full-time teachers of grade 4 and above) and according to how much computer technology they had (using an index incorporating ten different measures of per-capita technology presence).

The two purposive samples were compiled from a multitude of sources. The "educational reform" purposive sample (470 schools) came from rosters compiled of 52 different educational reform efforts gathered over the past several months. Twenty-nine of the programs are schoolwide reform programs; four are limited to either mathematics or science; and 19 enroll specific teachers as participants. Lists of

participating schools or teachers were obtained directly from the programs in 43 of the cases; in the other 9 they were obtained from public sources--lists of participants on World Wide Web sites or in books. (In some cases, these were not actually programs--just schools identified as exemplary in the public source.) Forty programs provided more schools than were needed so that probability sampling was employed to select the particular schools that would be incorporated into the study. (In some cases, additional selection criteria were used prior to the sampling.)

The high-end technology purposive sample (258 schools) was compiled from three types of sources: publicly available information from school Web sites and books, from one high-end technology education reform program, and from the Quality Education Data database (the schools with the highest technology presence index).

SELECTION OF TEACHERS

At each of the 1,616 studied schools, samples of 3 (elementary) or 5 (middle and high school) teachers were drawn through probability sampling methods. A Teacher Roster form was sent to the school principal as the first major mailing to the school (following an introductory letter). That form asked the principal to roster either 10 (elementary) or 15 (secondary) teachers of grade 4 or higher (in some cases limited to the same subject taught by a reform program-participating teacher), starting with teachers with last names beginning with a randomly selected letter of the alphabet and proceeding alphabetically. The roster form asked for 4 additional pieces of information about the rostered teachers that were used to assign sampling weights to each rostered teacher (e.g., subject taught, use of computers, use of projects in teaching).

In addition, two other sources of teachers are incorporated as purposive samples. Approximately 250 teachers were individually selected from the purposive school samples based on reports (public or program-supplied) of their participation in educational reform activities. And finally, approximately 800 teachers were chosen through nominations by principals (as part of the Roster form) as exemplary practitioners of constructivist approaches to teaching.

ATTAINED SAMPLE

With a 75% response rate at the Roster stage and close to a 70% response rate at the individual level, the survey database includes information from 1,150 schools including completed questionnaires from approximately 4,100 teachers, 800 technology coordinators, and 850 principals.